
Space Weather Technical Forecast

Issued on Sunday, 18 September 2022 at 01:17 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Slight Chance G1 into new UTC working week, as chances of R1 and S1 reduce.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the past 24 hours, with two M-class flares recorded at GOES16 from over the northwestern solar horizon. The first of these occurred at 17/1339UTC and registered as an M1.9. The source appeared to be near Ex-3098's expected position, with resulting ejecta seen leaving the disc above the ecliptic plane into the UTC evening. The second event was an M2.6 observed at 17/2041UTC, with this more likely to have emanated from Ex-AR3098 itself. At the time of writing, no Coronal Mass Ejection (CME) appeared to have been produced from this event, and no additional solar radiation enhancement was observed at GOES16.

There are currently three sunspot regions on the visible disc. The largest and nominally most complex of these remained AR3102 in the southeastern quadrant, which saw some growth in its trailing spot to attain Eai/Beta classification by the period's end. To its west, AR3103 presented as a fading Bxi/Beta group, while AR3100 saw its trailers fade to finish the 24 hours as a Cso/Beta. Activity from all of these regions failed to range beyond low C-class.

Coronagraph imagery for the 24 hours showed a slow high latitude release on both STEREO A COR2 and Lasco imagery. This ejecta is considered front-sided, but could not be tied to any obvious event, and in any case is considered to lie entirely off-ecliptic. Also observed were faint emissions heading both east and southwest, but perhaps most notably the CME tied to the M1.9 flare was seen heading northwest. This final feature has yet to be analysed, but is unlikely to have any Earth-based effects from this location.

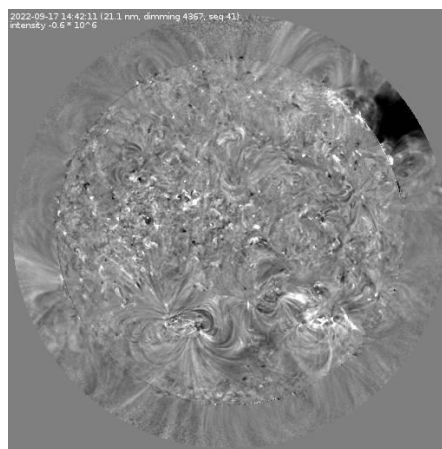


Figure 0: Time-integrated AIA211 imagery courtesy of SIDC ROB of the dimming tied to the M1.9 flare 17/1339UTC. This event has yet to be modelled, but Earth-based effects are considered unlikely.

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Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, followed a slow regime, but with a notable rising IMF from near 5nT to reach 11nT. The north-south component was small-scale and changeable initially, but became larger in magnitude, with more lasting forays into both co- and anti-aligned territory with time, with a peak range of +10 and -7nT.

The remainder of solar wind measures were more typical, with the solar wind speed showing an erratic rise from near 325 to 400km/s, while the density remained in single figures ppcc throughout. Finally, the phi angle was negative (towards the Sun).

The net result of the above solar wind measures was provisionally Quiet, at or below Kp2 throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained slightly elevated above background levels over the 24 hours, less than 2.5pfu and on a flat trend.

Electron flux was mainly at Normal Background levels, with diurnal peaks of the order of 250pfu during the afternoon of Saturday 17 September. The corresponding 24-hour electron fluence showed a gently reducing trend, with an observed fluence value at 18/0001UTC of 5.93e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to fall with the passing of AR3098, although for day one it probably remains near enough the front side to throw X-ray producing ejecta clear of the limb to give a peak Chance of M-class for the four days, otherwise being Slight.

Solar Wind / Geomagnetic Activity: There is one unified CME that features in the current forecast - the product of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant. These may give a glancing blow late in the UTC of Sunday 18 September, and a corresponding Slight Chance of G1.

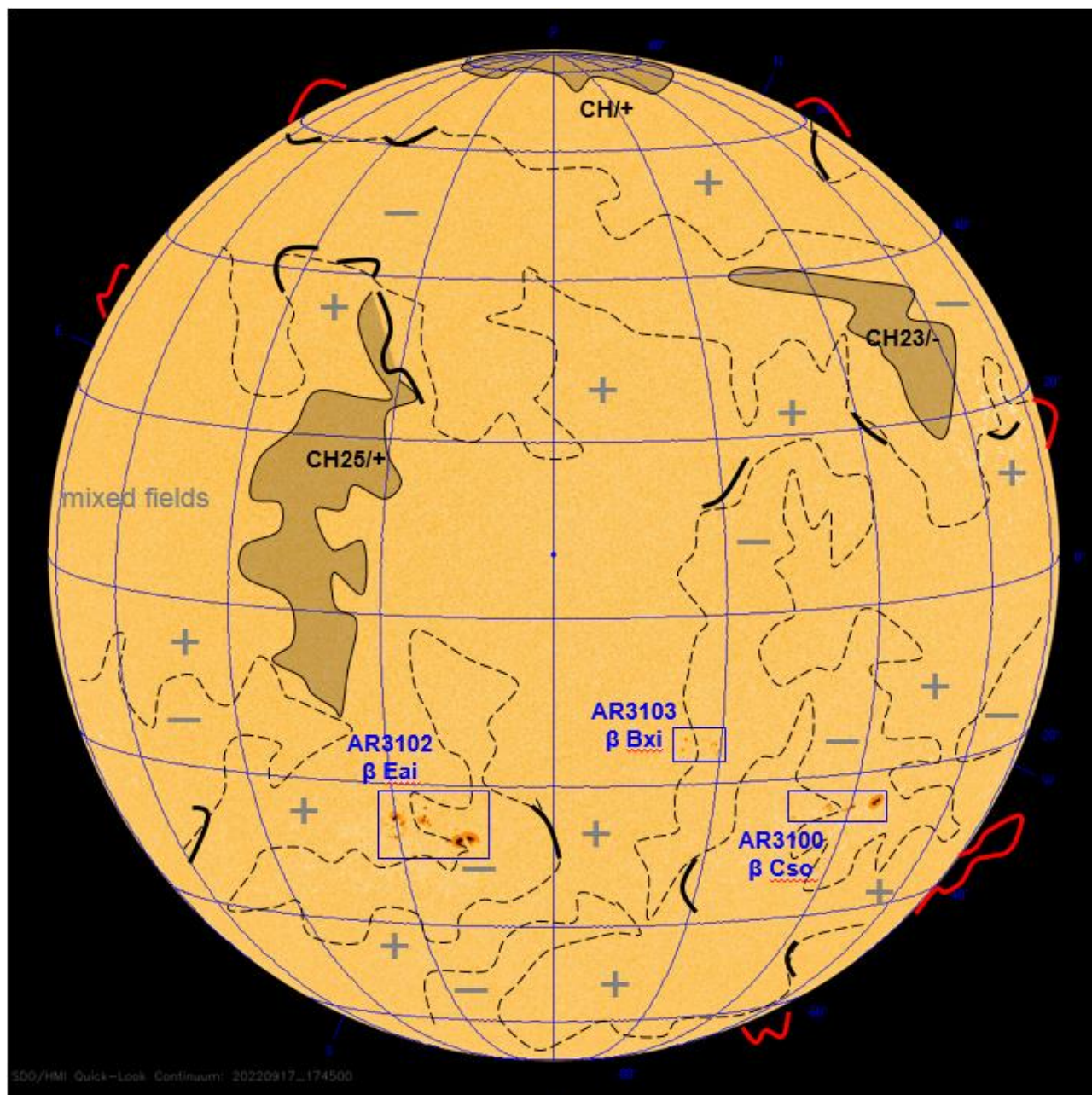
Coronal hole 23 (and/or 24) are overdue but signs at STEREO now suggest possible concurrent arrival with the above CME later on day one, Sunday 18 September.

Initially Quiet conditions may rise to a Slight Chance of G1 late Sunday 18 and through Monday 19 September, returning to Quiet from Tuesday.

Energetic Particles / Solar Radiation: The chances of S1+ level solar radiation storms are slightly elevated given the already enhanced environment at GEO, although the trend is downwards as the most liable spot to produce such events rotates away from a favourable position in the period.

The high energy electron flux (greater than 2MeV) is expected to remain at mainly Normal Background levels until after the onset of the coronal hole high speed stream and subsequent geomagnetic activity. There is now considered an eventual Chance of surpassing Active from day three, Tuesday 20 September.

Figure 1. Solar Analysis Valid 17/1745UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There is one unified CME that features in the current forecast - the product of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant. These may give a glancing blow late in the UTC of Sunday 18 September, and a corresponding Slight Chance of G1. The MOSWOC Enlil ensemble solutions are relatively tightly clustered around the tail end of the UTC day of Sunday 18 September, although this is probably more a result of the 636km/s speed involved rather than a measure of precision.

The persistence forecast would otherwise have an incumbent high speed stream from coronal hole 23 or perhaps 24. These fast winds had been due to arrive into the UTC weekend, however only now are there signs of an enhancement finally arriving at STEREO A, 1.6 days upwind. The very similar orbital latitudes of Earth and the STEREO satellite relative to the solar equator should mean that winds seen at this satellite are closely replicated at Earth, and now look likely to arrive later on day one, Sunday 18 September. The combined effects of both this fast wind and any CME are now expected to be a little more muted for the fast wind arriving late (and being smaller in magnitude), but greatest should it arrive concurrently with the above CME.

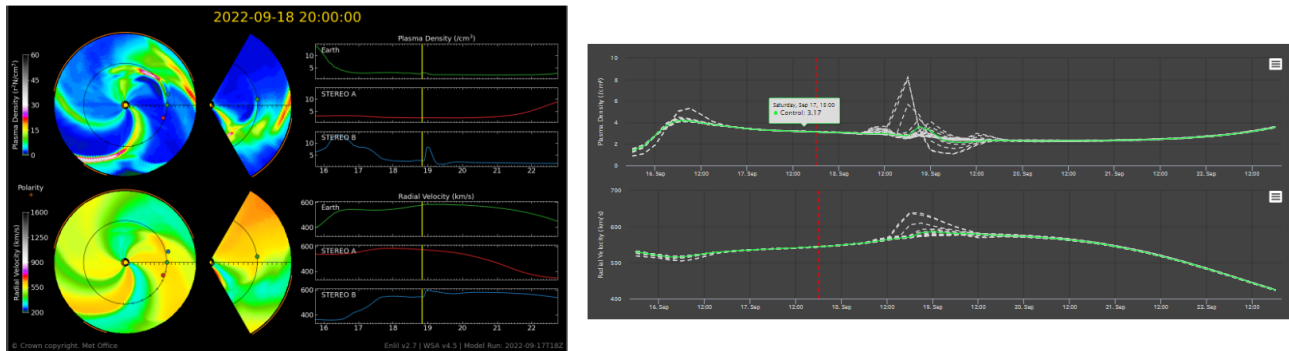
Initially Quiet conditions will rise to a Slight Chance of G1 late Sunday 18 and through Monday 19 September, returning to Quiet from Tuesday.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0703UTC	Partial	Filament eruption(s)	SW quadrant	636km/s	18/2100UTC	Lasco only. Formed of two filament CMEs 15/2100UTC and 16/0100UTC.

Figure 2: Latest MOSWOC Enlil run, which has maintained its consistent suggested arrival time for the filament CME of late in the UTC day of Sunday 18 September. Confidence remains lower than is typical, both for the single-perspective analysis but also because Enlil is currently modelling an erroneous 550km/s incumbent fast wind.



Radio Blackouts - X-Ray Flares:

There are currently three sunspot regions on the visible disc, with an additional fourth spot group - Ex-AR3098 - having crossed the northwestern limb around 24 hours ago. Even from longitudes beyond 100W this group is still proving capable of delivering parting shots, with a pair of low-end M-class flares and at least one CME observed on Saturday 17 September.

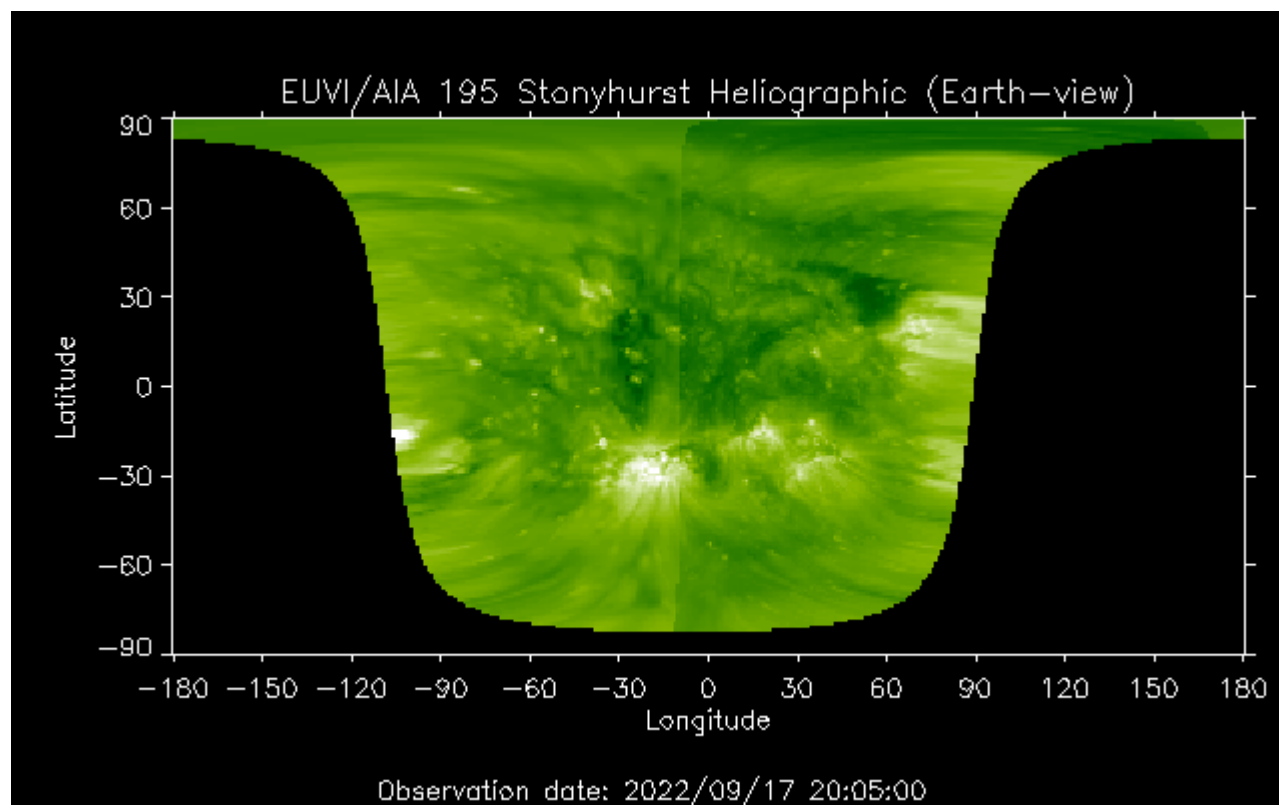
The surviving front-side cohort are all smaller and simpler, with only minor growth trends observed, perhaps most significantly in AR3102, which finished the 24 hours as an Eai/Beta, but without producing noteworthy flares.

Regarding the possibility of returning regions, STEREO A EUVI 195 now shows Ex-3089 as lying on its eastern limb, putting arrival over the limb from Earth's perspective as later on Monday 19 September. Any increase in flare probabilities will take place once this group presents for analysis.

The probabilities of M-class flares are maintained slightly elevated as a result of Ex-AR3098, however this should have rotated sufficiently far from the limb into the new working week UTC for the risk to lessen, from here only accounting for the current front side spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	20	20	20
Very Active	R3 to R5 X Class	No	5	1	1	1

Figure 3: STEREO A EUV perspective of an approaching southeastern limb spot group, probably corresponding to Ex-3089.



Solar Radiation Storms - (High Energy Protons):

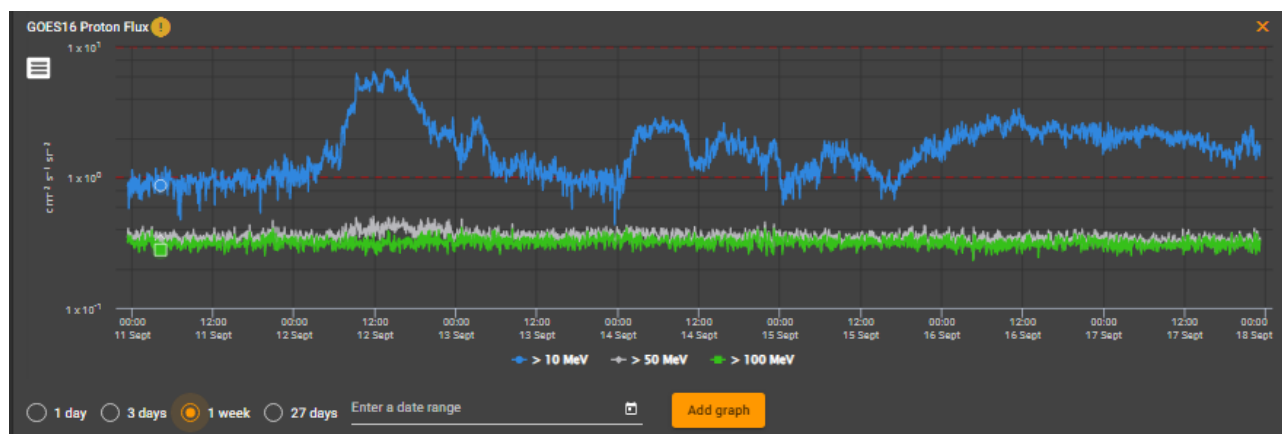
The high energy proton flux (greater than 10MeV) remains slightly elevated, but sub-S1.

Fortunately, despite five M-class flares in recent days, Ex-AR3098 for whatever reason does not appear to be particularly conducive to producing proton enhancements, even in its current position over the northwestern limb. The cause of the current enhancement(s) is not certain, perhaps being related to unseen far-side activity.

The peak risk of S1 still comes on day one, with a gradual ebb otherwise expected over the subsequent three days. This raised risk is due to both Ex-AR3098, and also the higher baseline at present, gradually falling toward a nominal background towards midweek (barring far side activity maintaining counts at GEO).

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

Figure 4: Past week in high energy protons, with greater than 10MeV shown in blue. The S1 threshold, 10pfu corresponds to the very top of the plot.



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2MeV) is expected to continue its current very modest Normal Background to Moderate flux oscillation until after the advent of CH23/- and/or CH24/-.

These fast winds had been due to arrive into the UTC weekend, but now appear likely to arrive later on day one, Sunday 18 September. The combined effects of both this fast wind and any CME from the filaments observed 15/2100UTC and 16/0100UTC should lead to an initially turbulent electron trace, eventually rising into day three, Tuesday 20 September.

Because electron fluence levels were very marginal for exceedance of the Active threshold on last pass and the synonymous feature is later and presumably slower on this outing, the chances of similar are thought to be lower. All considered, flux and fluence should rise early in the new week, with a Chance of surpassing Active from Tuesday.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	10	30	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1